Computational Aerodynamics Questions & Answers

Question by Student 201327133

Professor, I have a question about τ. I understood that η and ξ mean each line number of horizontal and vertical grid. But i don't know what is physical meaning of τ. If i know that, it much easier to understand the class.

τ is the same as t because we set Γ to 1. 1 point bonus.

Question by Student 201327103

Professor, I think the problem is i and x are not in same direction. In previous example, i axis and x axis are in same direction. So that computer can decide x component first with setted space and than decide y component form equation

$y = sin(15x/L)H/20$

Here the space doesn't change with y But in this problem space change with x and y. So, computer may not find proper point of nodes which have setted space through $x^2 + y^2 = r^2$. Because I don't know the computer codes in detail, I can't approach to the solution.

You're on the right track. It has something to do with the fact that it's difficult to find a root for y on a circle at $x = \pm r_{\rm i}$. Because the method used to solve the equation within the Equation() command is a Newton-Raphson non-linear root solver, it may fail close to $x = \pm r_{\rm i}$ depending on the initial guess or the size of the first Δx given to the solver. Say for example that x is at $-r_{\rm i}$ and Δx is set to -10^{-10} m, then this will result in a negative value for y^2 in the Newton-Raphson procedure, and the Equation command will fail. I'll explain this better through an example next class. 2 points bonus.

Question by Student 201227125

Professor, at assignment 2-Question #3, x and y has dimension that is length(unit mm). In this case, dose ξ and η also have dimension or not?

No, ξ and η don't have dimensions. But their derivatives do of course. So ξ_x, η_x, etc will have dimensions (1/m or 1/mm). 1 point bonus.

Question by Student 201227148

Sir, I can not get my CFD password. I entered my email address. But I can not log in.

Try again now.

Question by Student 201427116

Professor, We learned how to find wave speed from Flux Jacobian on last class. After finding all elements of Jacobian , you showed the way to extract wave speeds from Jacobian. In this process, you found 3 eigenvalues of Jacobian which are expressed by

$\phi_1, \phi_2, and \phi_3, respectively.$

And said, these eigenvalues represent each wave speeds.

But I cannot understand the relation between eigenvalues of Jacobian and wave speed. How do I confirm that these eigenvalues should be wave speed? What relationship is involved in this process?

Consider a system of equations as follows:

$$\frac{\partial U}{\partial t} + A\frac{\partial U}{\partial x} = 0$$

Recall that the eigenvalues are such that $A = L^{-1}\Lambda L$:

$$\frac{\partial U}{\partial t} + L^{-1}\Lambda L\frac{\partial U}{\partial x} = 0$$

Multiply by L:

$$L\frac{\partial U}{\partial t} + \Lambda L\frac{\partial U}{\partial x} = 0$$

Say that a vector W exists such that $L = \partial W/\partial U$. Further, because $L = L(U)$, it follows that $W = W(U)$. Thus, we can say

$$\frac{\partial W}{\partial t} = L\frac{\partial U}{\partial t} \quad \text{and} \quad \frac{\partial W}{\partial x} = L\frac{\partial U}{\partial x}$$

Substitute the RHS of the latter 2 equations in the former:

$$\frac{\partial W}{\partial t} + \Lambda\frac{\partial W}{\partial x} = 0$$

Because $\Lambda = [\phi_1,\ \phi_2,\ \phi_3]^{\rm D}$ is diagonal, the latter is simply a list of advection equations each with a wave speed ϕ_1, ϕ_2, ϕ_3. Good question: 2 points bonus.

Question by Student 201327132

Dear professor. We derived Euler equations in genrealized coordinate. First we start

$$\frac{\partial U}{\partial \tau} + \xi_x \frac{\partial F_x}{\partial \xi} + \eta_x \frac{\partial F_x}{\partial \eta} + \xi_y \frac{\partial F_y}{\partial \xi} + \eta_y \frac{\partial F_y}{\partial \eta} = 0$$

Second we multiply by Ω. *But I think, we don't need to multiply* Ω. *Because here,*

$$\frac{\partial U}{\partial \tau} + \frac{\partial F_x \xi_x}{\partial \xi} - F_x \frac{\partial \xi_x}{\partial \xi} + \frac{\partial F_x \eta_x}{\partial \eta} - F_x \frac{\partial \eta_x}{\partial \eta} + \frac{\partial F_y \xi_y}{\partial \xi} - F_y \frac{\partial \xi_y}{\partial \xi} + \frac{\partial F_y \eta_y}{\partial \eta}$$
$$- F_y \frac{\partial \eta_y}{\partial \eta} = 0$$

And,

$$-F_x \left(\frac{\partial \xi_x}{\partial \xi} - \frac{\partial \eta_x}{\partial \eta}\right) = -F_x \left(\frac{\partial}{\partial x}\frac{\partial \xi}{\partial \xi} - \frac{\partial}{\partial x}\frac{\partial \eta}{\partial \eta}\right) = 0$$

I think, this is more simple equation.

$$\frac{\partial U}{\partial \tau} + \frac{\partial F_x \xi_x}{\partial \xi} + \frac{\partial F_x \eta_x}{\partial \eta} + \frac{\partial F_y \xi_y}{\partial \xi} + \frac{\partial F_y \eta_y}{\partial \eta} = 0$$

I want to know why we use Ω. *Thank you.*

The problem with your logic is that $\partial \xi_x / \partial \xi$ is not zero because ξ_x can vary along the the ξ coordinate. Similarly, $\partial \eta_x / \partial \eta$ is also not zero because η_x can vary along η. Good question, 2 points bonus.

Question by Student 201327132

Dear professor, I have a question about WENO. We learned about what γ_0, γ_1 *became* W_0, W_1 *when* $\beta_0 \simeq \beta_1$.

But I found that γ_0 *became* W_0 *when* $\beta_0 \gg \beta_1$. $\widetilde{W}_0 = \frac{\gamma_0}{(\epsilon+\beta_0)^2}$, $\widetilde{W}_1 = \frac{\gamma_1}{(\epsilon+\beta_1)^2}$ *and*

$$W_0 = \frac{\widetilde{W}_0}{\widetilde{W}_0 + \widetilde{W}_1}$$

And $\gamma_0 + \gamma_1 = 1$. *So*

$$\widetilde{W}_0 + \widetilde{W}_1 = \frac{1}{(\epsilon + \beta_0)^2 + (\epsilon + \beta_1)^2}$$

$$W_0 = \frac{\gamma_0}{(\epsilon + \beta_0)^2} \cdot ((\epsilon + \beta_0)^2 + (\epsilon + \beta_1)^2)$$

Because of $\beta_0 \gg \beta_1$.

$$W_0 \simeq \frac{\gamma_0}{(\epsilon + \beta_0)^2} \cdot (\epsilon + \beta_0)^2$$

Finally $W_0 = \gamma_0$. *And vice versa* W_1. *Is it ok or something wrong? I think it is not satisfied only* $\beta_0 \simeq \beta_1$.

The problem in your math is here:

$$\widetilde{W}_0 + \widetilde{W}_1 = \frac{1}{(\epsilon+\beta_0)^2 + (\epsilon+\beta_1)^2}$$

This is not correct. Rather:

$$\widetilde{W}_0 + \widetilde{W}_1 = \frac{\gamma_0}{(\epsilon+\beta_0)^2} + \frac{\gamma_1}{(\epsilon+\beta_1)^2} \quad (1)$$

$$= \frac{\gamma_0(\epsilon+\beta_1)^2 + \gamma_1(\epsilon+\beta_0)^2}{(\epsilon+\beta_0)^2(\epsilon+\beta_1)^2} \quad (2)$$

Question by Student 201327132

Dear professor. In design problem 3, Should we consider about cowl length?? If so, how do we obtain cowl length?? I've been thinking for a long time. I can not find the length. Thank you.

The cowl starts where the domain ends. So, there is no need to grid the cowl and there's hence no need to know the cowl length. The important thing is that your waves (either the Mach waves for the Prandtl-Meyer compression fan case or the shock waves for the 3-oblique-shock case) all meet at the same point and such a point is located exactly at the domain exit.

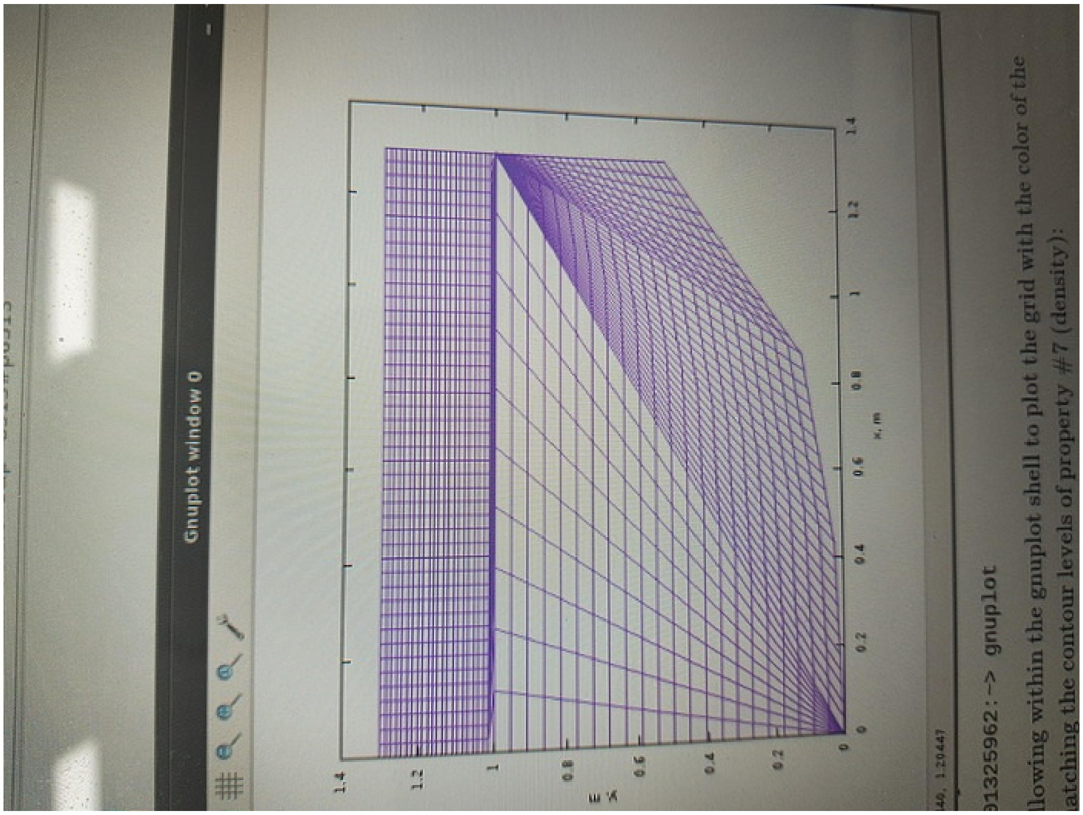
Question by Student 201327132

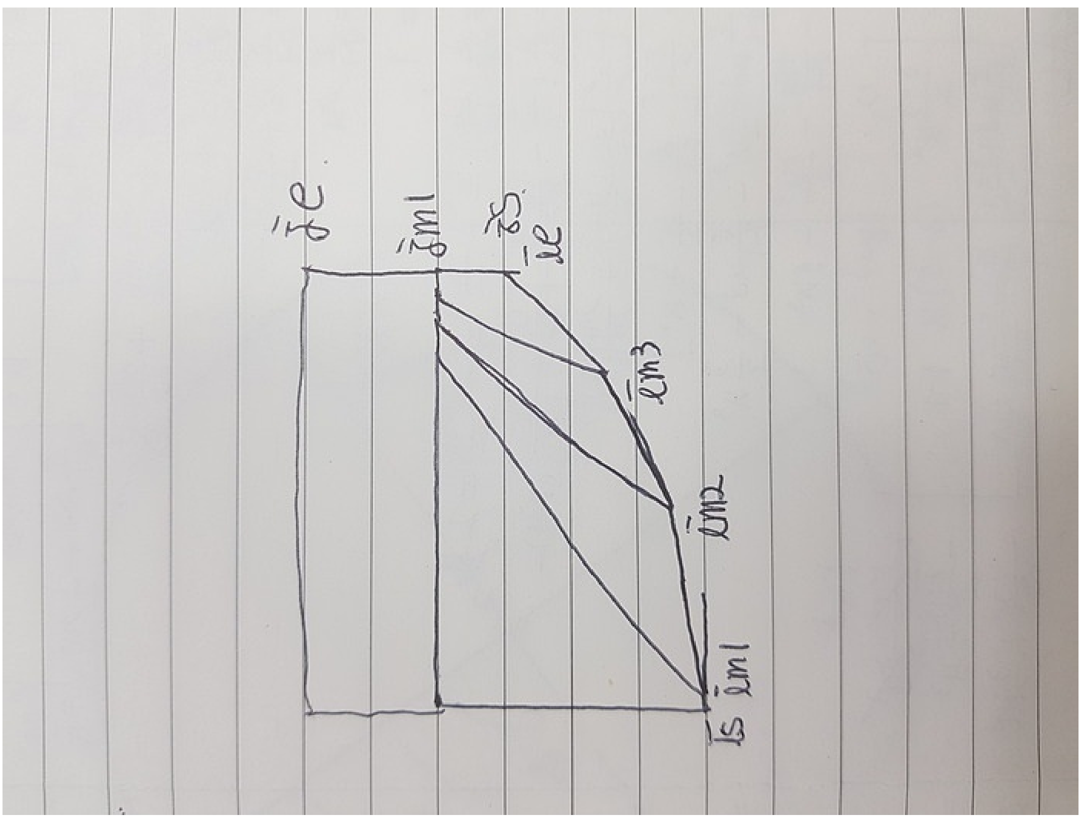
Professor, I have a question about design. In problem 3, Should we consider about 3 shocks when I generate grid? I made grid that is consider 3shocks. But I think it is not correct grid. If we should consider about 3 shocks, Would you please some hint for me?

Yes, for problem 3, there should be 3 oblique shocks and the pressure ratio across each shock should be the same. You need to design your inlet so that these 3 shocks appear, have all the same pressure ratio, and meet at one point. I am not sure what you don't understand. Can you explain better the problem?

Question by Student 201327132

Thank you professor. I have a problem with some grid. My strategy is attached pircture. To generate oblique shocks, I set the very small value that is length of between (im 1, jm 1) and (im 2, jm2). Likewise (im 3, jm3) and (ie, js). And plot the my strategy(also i attatched picture). I think it is not correct method, but i didnt find better method. Sorry for my lack of explanation.





Your grid has issues. You should make the grid so that the spacing is more or less uniform everywhere. Don't worry about making the grid parallel to the shocks. The shocks can go through the cells at an angle — this is fine. Simply make sure that your bottom wall has the right shape, that the cells are more or less of the same size everywhere (and are not distorted as in your mesh), and the shocks will appear correctly positioned.

Question by Student 201327103

professor, How can I open the post file? I want to know number of properties, like density : 7, but I can't open the post file.

The instructions are in the CFDWARP HOWTO here:

https://bernardparent.ca/viewtopic.php? ... 6568#p6568

You need to read in the data file with the -i flag and output it to a post file with the -op flag. Also, specify a gnuplot datafile with the -pt gnuplot flag.

Question by Student 201427116

Professor, I am doing Design Problem #2, flow over cylinder. After manipulating some code, I printed out drag coefficient but found some weird drag coefficient. The drag coefficient had negative value. Can I ask you some advice for this negative coefficient?

Also, I cannot understand what those xstation[] or Area[dim] in Post() module mean. If I need all of xstation[1], xstation[2], and xstation[3]? or can I just erase it? It will be big pleasure of me to learn more about that. Then I may find out some errors in that Post(). Thank you.

Please attach a picture of the pressure contours around your cylinder. Maybe your flow is not yet at steady-state. Because you are doing the cylinder case, you don't need the xstation. Inside the Post() module, delete the part about the x-station and only keep the line Fpressure[dim]=_Fpressure(... Then, add a bit of code to find the drag coefficient using Fpressure[1] (the pressure force acting on the body along x).

Question by Student 201327132

Professor, I have a question about design problem No.4. I run a my case. And I tried to find converge point of shock. But I don't know each shock angle at point. Do I need the shock angle? If not so, I think we should know length of between each shock. I have tried a lot. I didn't find converge point. Thank you.

Problem 4 is harder than the others. You need to find σ and δ for each shock using the obliqueshock program. Once this is done, you need to find the bottom surface of the ramp that will make all shocks meet each other at one point (such is only function of H, and the 3 δs and σs). Thus, this requires a bit of geometrical calculations on paper. I recommend another problem if this is taking too long.